Monetary Policy as Financial-Stability Regulation

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The Mission of Central Banks

- Modern view: *price stability* is paramount goal.
- Historical view: *financial stability* also a core mission.
  - Goodhart (1988): central banks arose because unregulated free banking kept leading to panics.
  - Bagehot (1873) on lender of last resort.
- Recent events highlight financial-stability role.
- This paper: goals and methods of central-bank financial-stability policies. I try to address three questions:
  - What is the fundamental market failure?
  - What mix of tools should be used?
  - When does monetary policy help, and how does it influence bank lending and investment?

The Market Failure: Excessive Private Money Creation by Unregulated Banks

- Banks finance themselves with debt claims
- If debt is completely riskless, it is "money": provides transaction services; households accept lower yield.
- Only way for banks to make debt riskless is to make it short-term—this gives effective seniority.
- Short-term debt can lead to banking crises with fire sales, which have real effects that banks don't fully internalize.
- Bottom line: some private money creation is good. But unregulated banks do too much.

Monetary Policy as a Tool to Fix the Externality

1. A Crude Policy: Cap on Money Creation
   - Constrain banks' issuance of short-term debt. This can raise welfare.
   - Like Basel III's net stable funding ratio.
2. A Better Policy: Cap and Trade
   - Regulator issues permits that allow banks to create money. Permits trade among banks. Price reveals useful info to regulator—if price is high, may want to loosen cap.

   Note: so far this is an entirely real economy.

3. Monetary Policy As Mechanism to Implement Cap and Trade Regulation.
   - Gov't issues two types of nominal liabilities: T-bills and reserves.
   - Price level determined by total nominal gov't liabilities (fiscal theory).
   - Banks are required to hold reserves in order to create money. T-bills don't count towards reserve requirements.
   - So *composition* of government liabilities is a real variable: more reserves = more permits for banks to issue short-term debt.
   - And price of permits = cost of holding reserves = nominal interest rate.

Implementation with Interest on Reserves

- With interest on reserves, can write funds rate r as: $r = IOR + SVR$.
  - IOR = interest paid on reserves.
  - SVR = scarcity value of reserves.
- Macro academics have argued for "floor" systems as in New Zealand, where reserves are plentiful.
  - $SVR = 0$; $r = IOR$. All policy adjustment done via IOR.
  - Friedman-rule logic: reserves serve a valuable purpose; don't tax them.
- By contrast, this paper offers a normative theory of why SVR should be non-zero and time-varying.
  - Nominal rate i in the model is exactly the SVR.
- So can have two tools for two objectives.
  - Set funds rate r based on aggregate-demand objectives (Taylor rule).
  - Set SVR to optimally regulate short-term debt, as in the model.
  - Suggests reserve requirements should apply to broader class of liabilities: essentially any financial-firm short-term debt.

Complementary Tools

- Deposit insurance and lender-of-last resort.
  - Unlike in Diamond-Dybvig (1983), here there is a risk of deposit insurer losing money.
  - If bailouts are costly (e.g., deadweight costs of taxation) will be optimal to insure only a fraction of privately-created money. Still need to regulate the rest.
- Regulation of shadow-banking sector.
  - Baseline model applies to simple banking system where all privately-created money is subject to reserve requirements.
  - If shadow banks create money, they too should be subject to reserve requirements.
  - Or regulate repo haircuts as second-best alternative.
- Government debt maturity (Greenwood-Hanson-Stein).
  - Treasury can issue more short-term T-bills to crowd out private money creation by banks.

Key Building Blocks

- Fire sales: Shleifer-Vishny (1992, 1997).
  - Also: Allen and Gale (2005), Brunnermeier and Pedersen (2009), Fostel and Geanakoplos (2008), Geanakoplos (2009), Gromb and Vayanos (2002), Morris and Shin (2004), Caballero and Simsek (2009).
- Banks create "money" by issuing low-risk claims: Gorton and Pennacchi (1990).
- Bank lending channel: Bernanke and Blinder (1988, 1992), Kashyap, Stein and Wilcox (1993), and Kashyap and Stein (2000).
  - Reserves as permits for issuing deposits: Stein (1998).
- Fiscal theory of the price level: Leeper (1991), Sims (1994), Woodford (1995), and Cochrane (1998).

A Model of Private Money Creation

- **Households:** Initial endowments at time 0. Choose between immediate consumption and investment in riskless "money" or risky "bonds".
- **Banks:** Raise money from households at time 0 by issuing money and bonds. Invest in portfolios of real projects that pay off at time 2.
  - To be riskless, money must be short-term (maturing at time 1) debt.
  - In bad state of the world, banks may have to sell off projects at time 1 to service this short-term debt.
- **Patient Investors (PIs):** Receive endowment of W at time 1: a war chest that can be used for opportunistic investments.
  - Can buy existing assets at fire-sale discount from banks at time 1.
  - Or invest in new, late-arrival projects.
  - But cannot raise further funds at time 1.
  - As discount rises, investing in new projects becomes less attractive (Diamond-Rajan (10), Shleifer-Vishny (10)); a real cost of fire sales.

Households

- Linear preferences over early (time 0) and late (time 1 or time 2) consumption. Also get utility from monetary services: any privately-created claim on late consumption, so long as *completely riskless*.
- Utility of a representative household is given by:

$$U = C_0 + \beta E(C_1 + C_2) + \gamma M$$

  - Convention: saying a household has M units of money at time 0 means it holds claims that are *guaranteed* to deliver M units of time-2 consumption.

- Gross real return on risky "bonds" that pay off at time 2: $R^B = 1/\beta$.

- Gross real return on riskless "money": $R^M = 1/(\beta+\gamma)$.
  - Like in standard model, monetary services imply a convenience yield.
  - But unlike in standard model, money-bond spread is *invariant to quantity of* M—thanks to linear preferences. For starkness, not realism.

Banks

- Continuum of banks with total mass one. Each bank can invest a variable amount I at time 0.
- **Bank asset-side technology:**
  - In good state (ex ante prob p), output at time 2 = $f(I) > I$.
  - In rare "crisis" state (ex ante prob $(1 - p)$) *expected* output at time 2 of each bank = $\lambda I \leq I$, but there is non-zero chance that output = 0.
  - State is revealed at time 1.
  - In crisis, bank can sell a fraction Δ of assets at time 1 to a PI. Sale yields $\Delta k \lambda I$, where $k \leq 1$ is discount determined endogenously.
- **Comments on assumptions:**
  - Model aggregates banks and their borrowers for simplicity. Equivalent to assuming no contracting frictions; borrowers can pledge all output to banks.
  - So in what sense is this about banks and not operating firms? If individual firms have idiosyncratic prob of total failure (output = 0) by time 1, diversification allows a bank to issue riskless money which firms cannot do.

Bank Financing Options

- Can raise I either with short-term or long-term debt. Only short-term debt can be riskless, given chance of zero output at time 2.
- Banks want to issue short-term debt to create money, which is cheaper source of funding.
- But this leads to fire sales in crisis; costs of fire sales not fully internalized by banks when choosing debt structure.
- Suppose bank raises fraction m of investment with short-term debt.
  - If riskless, promised repayment is $M = mIR^M$.
  - To meet promise in crisis with asset sales, require: $\Delta k\lambda I = mIR^M$.
- So upper bound on private money creation is $m^{\max} = \dfrac{k\lambda}{R^M}$
- Note asset sales are unavoidable given overhang of long-term debt.

Patient Investors

- PIs have total resources of W at time 1. Can invest an amount $K \leq W$ in new late-arrival projects.
- Total output from investment in new projects is $g(K)$.
- **In good state:** PIs invest all funds in new projects: $K = W$.
- **In crisis state:** PIs absorb fire-sale assets from banks, invest rest in new projects.
  - Value of asset sales = M (banks need to sell enough to pay off short-term debt).
  - So $K = (W - M)$.
- PIs must be indifferent between buying assets from banks and investing in new projects, which implies:

$$\frac{1}{k} = g'(W - M)$$

  - As M rises, so do crisis-state liquidations. This makes PI capital scarcer, and drives down asset resale value k.

Bank's Optimization Problem

- Bank's expected profit Π is given by:

$$\Pi = \{pf(I) + (1-p)\lambda I - IR^B\} + \frac{M}{R^M}(R^B - R^M) - (1-p)zM$$

where $z = (1 - k)/k$ is net rate of return on fire-sold assets.

- Each bank takes *z* as fixed when formulating its decisions; optimizes by picking *m* and *I*.
- Bank will go to a corner solution, setting $m^* = m^{max}$ if:

  $(R^B - R^M) > (1 - p)zR^M$, i.e., if fire-sale losses not too big relative to spread between bonds and money.

Privately-Optimal Money Creation

- Define I^B as optimal investment in all-bond-financed world:

$$pf'(I^B) + (1-p)\lambda - R^B = 0$$

- **Proposition 1:** The solution to the bank's problem involves two regions:
  - Low-spread region (for $(R^B - R^M)$ small): $m^* < m^{max}$ and $I^* = I^B$.
  - High-spread region (for $(R^B - R^M)$ large): $m^* = m^{max}$ and $I^* > I^B$.

Social Planner's Problem

- Social planner's utility given by:

$$U = \{pf(I) + (1-p)\lambda I - IR^B\} + M\frac{(R^B - R^M)}{R^M} +$$
$$pg(W) + (1-p)\{g(W-M) + M\} - WR^B$$

- **Proposition 2:** Denote private and socially optimal values of investment I by I^* and I^{**} respectively, and similarly for private and socially optimal values of money creation M. In low-spread region, $I^* = I^{**}$, and $M^* = M^{**}$. In high-spread region, $I^* > I^{**}$, and $M^* > M^{**}$.

What Happens if Planner Can Put a Cap on Money Creation?

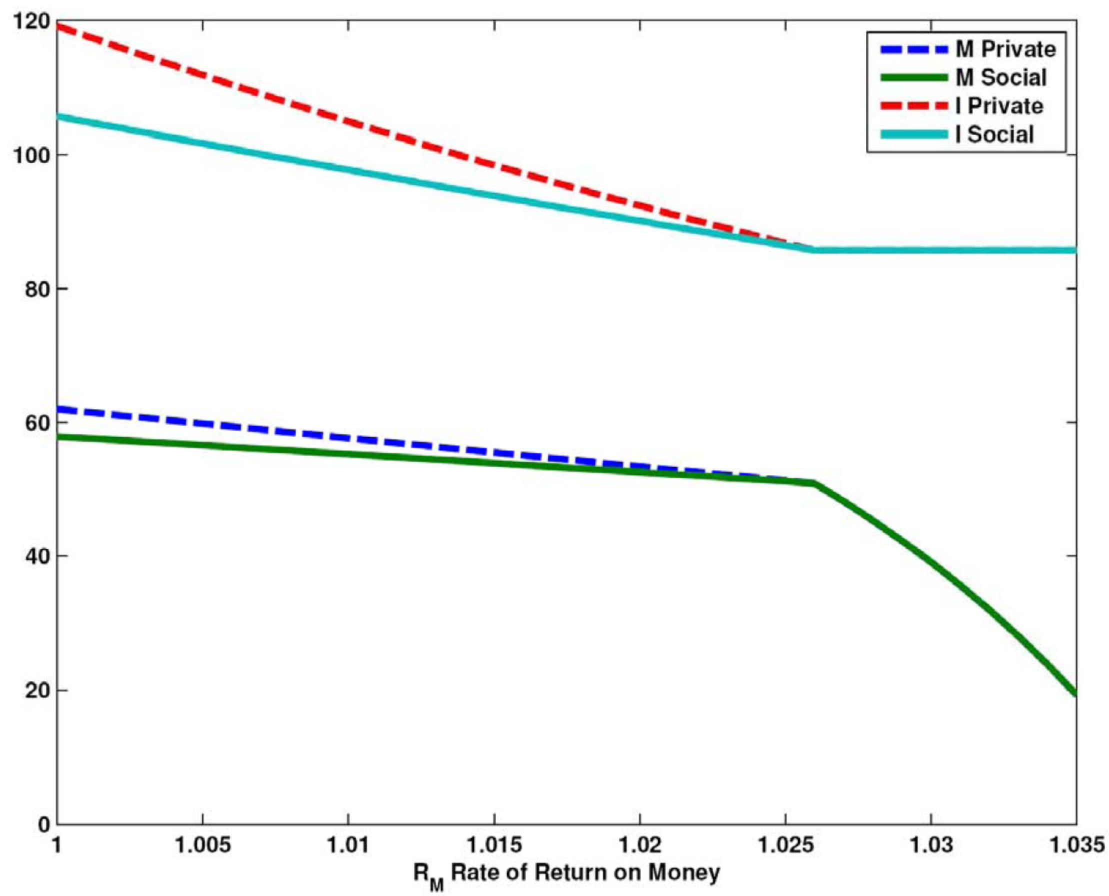
- Suppose we let planner pick socially optimal level of money creation M^{**}.
  - In low-M region, planner's solution coincides with private optimum: $M^{**}=M^{*}$.
  - In high-M region, planner wants to restrain money creation: $M^{**}< M^{*}$, and hence $I^{**}<I^{*}$ (since $m = m^{max}$).
- Intuition: bank does not internalize negative impact of its own money creation on ability of other banks to create money.
  - As bank A creates more M, equilibrium value of k falls and bank B can create less M for a given level of I.
  - Like pollution that gums up bank B's production technology.
  - Key to externality is binding collateral constraint.

Numerical Example

- Pick functional forms and parameter values:
  - $f(I) = \psi \log(I) + I$
  - $g(K) = \theta \log(K)$
  - $R^B = 1.04$; $R^M = 1.01$; $\psi = 3.5$; $\theta = 150$; $\lambda = 1$; $W = 140$; $p = 0.98$.
- Private optimum: banks choose $M^* = 57.6$.
  - At private optimum, $I^* = 104.9$;
  - And rate of return z on fire-sale assets = 82.1% ($k = 0.549$).
- Social optimum: planner chooses $M^{**} = 55.2$.
  - At social optimum, $I^{**} = 97.7$;
  - And rate of return z on fire-sale assets = 77.0% ($k = 0.565$).
- This is a high-M equilibrium.
  - Planner actively constrains money creation.
  - In neighborhood of social optimum, dI/dM is positive: changes in the cap matter for investment.

Figure 1
Private and Socially Optimal Outcomes Versus the Money-Bond Spread

The figure plots private and socially optimal values of money creation M and investment I as a function of R^M. Functional forms and parameter values are as follows: $f(I) = \psi\log(I) + I$; $g(K) = \theta\log(K)$; $R^B = 1.04$; $\psi = 3.5$; $\theta = 150$; $\lambda = 1$; $W = 140$; and $p = 0.98$. R^M varies between 1.0 and 1.035.



Flexible Regulation: The Advantage of Cap and Trade

- To implement socially optimal M^{**}, planner needs to know all the relevant parameters of the model.
  - What if, e.g. investment-productivity parameter ψ is known by banks but not by the planner?
  - Planner can grant permits for money creation to banks, and allow them to be traded.
  - Price of permits is given by:

$$\frac{d\Pi}{dM} = \{pf'(I) + (1-p)\lambda - R^B\}\left[\frac{dI}{dM}\right]_{Bank} + \frac{(R^B - R^M)}{R^M} - (1-p)z$$

  - If planner knows all other parameters, permit price reveals investment productivity, allows planner to select correct value of M^{**}.

Numerical Example, Cont'd

- Suppose, as above, we begin in a world where $\psi = 3.5$.
  - Planner knows this, and sets cap accordingly: $M^{**} = 55.2$.
  - At this value, planner expects permits to trade for a price of 0.0056.
- But then there is a productivity shock, such that $\psi = 4.0$.
  - Because of higher marginal productivity of investment, permits now trade for a price of 0.0146.
  - This higher permit price allows planner to learn the new value of ψ.
  - Can then adjust the cap to new optimal value of $M^{**} = 58.9$.
  - At new optimum, permits trade for a price of 0.0054.
- Note that optimal regulation involves the planner actively stabilizing the price of permits.
  - When price of permits rises, regulator infers that productive opportunities have increased, and loosens the cap.

Introducing a Monetary Dimension

- Basic idea: monetary policy as a particular mechanism for implementing the cap and trade approach to regulation.
  - Bank reserves play the role of permits to create money.
  - And the nominal interest rate plays the role of the permit price.
- The subtlety: so far have been working in an entirely real setting.
  - Need to introduce nominal government liabilities, and pin down the price level.
  - Will do so using fiscal theory of the price level.

The Government's Balance Sheet

- Government raises fixed *real* tax revenues of T at time 2.
- Government has stock of outstanding *nominal* liabilities at time 0, composed of Treasury bonds and reserves: $l_0 = b_0 + r_0$.

- Need to pin down time-0 price level Λ_0 and riskless nominal interest rate i.

  - Time-2 price level then given by: $\Lambda_2 = \frac{\Lambda_0(1+i)}{R^M}$

- Λ_0 determined by fiscal theory: PV of future tax revenues must equal value of government liabilities:

$$\frac{l_0}{\Lambda_0} = \frac{T}{R^M}$$

  - As in e.g. Cochrane (98).
  - Am assuming that government rebates any seignorage revenue in a lump sum so real tax revenues always stay fixed at T.

How Open-Market Operations Determine Nominal Interest Rates and Real Activity

- With fractional reserve requirement of ρ, cap on (net) real money creation given by:

$$M = \frac{(1-\rho)r_0}{\rho\Lambda_0} = \frac{(1-\rho)T}{\rho R^M}\frac{r_0}{l_0}$$

  - So *composition* of government liabilities—bonds vs. reserves—is a real variable: only reserves enable money creation.
  - Central bank open-market operations correspond to changes in supply of permits for creating private money.
- If a bank wishes to expand net M by one unit, and hence real time-2 profits by $d\Pi/dM$, must finance holdings of $\rho/(1-\rho)$ reserves at time 0.
- This entails a net repayment of $\rho i/(1-\rho)$ at time 2, or $\rho i/(1-\rho)P_2$ in real terms.
- Can use this to show: $$\frac{i}{(1+i)} = \frac{(1-\rho)}{\rho R^M}\frac{d\Pi}{dM}$$
  - Nominal interest rate plays role of price of permits in this setting.

Numerical Example, Cont'd

- Return to case where $R^B = 1.04$; $R^M = 1.01$; $\psi = 3.5$.
  - At social optimum of $M^{**} = 55.2$, permit price = $d\Pi/dM = 0.0056$.
  - With fractional reserve requirement of $\rho = .10$, this corresponds to nominal riskless rate $i = 5.25\%$.
  - Since i exceeds real riskless rate of 2.0%, implied inflation is 4.25%.

- Keep all else the same, but set $R^M = 1.02$. At new social optimum of $M^{**} = 52.5$, get $i = 1.81\%$.
  - Lower spread between money and bonds makes money creation less attractive, reduces need to impose a reserves tax.

Monetary Policy With Interest on Reserves

- In above model, there is only one tool—nominal interest rate i—and one objective—financial stability.
  - Price stability is dealt with elsewhere, via fiscal theory (or commodity standard).
- If central bank is also responsible for price stability, it will help to have another tool: interest on reserves.
- With interest on reserves, can write funds rate r as: $r = IOR + SVR$.
  - IOR = interest paid on reserves.
  - SVR = scarcity value of reserves.
- Nominal rate i in the model corresponds exactly to SVR.
- So can have two tools for two objectives.
  - Set funds rate r as in e.g., a Taylor rule.
  - Set SVR to optimally regulate short-term debt, as in the model.

Deposit Insurance

- Why not just stop fire sales by insuring all short-term bank liabilities?
  - Unlike Diamond-Dybvig (83), a chance that projects have zero value at maturity. So government will be on the hook.
  - Suppose deadweight costs of taxation take following form: no cost to raising anything less than L to pay for bailout, but infinitely costly to raise anything more than L.
  - Government will insure an amount L of private money, rest will be left uninsured.
  - Model works same as before, except costs of fire sales are reduced:

$$\frac{1}{k} = g'(W - M + L)$$

  - Isomorphic to increasing PI wealth by L. Deposit insurance and monetary policy are complements, neither dominates the other.
- Similar story for lender of last resort.

Regulating the Shadow-Banking Sector

- Thus far, have assumed that all privately-created money is subject to reserve requirements.
  - A better representation of a simpler time in history than of a modern advanced economy.
  - Gorton-Metrick (2009), Gorton (2010) emphasize repo as another form of private money creation.
- Logic of model suggests that repo should also be subject to reserve requirements. If not, haircut regulation may be second-best option.
  - Like a margin requirement for asset-backed securities.
  - Impose a cap on *fraction* of assets that can be financed with short-term debt: $m^{cap} < m^{max}$.
  - In general, not as good as directly controlling quantity of M.

Government Debt Maturity

- Another device to control the externality: reduce incentives for private money creation by compressing the bond-money spread ($R^B – R^M$).
  - Spread is exogenously fixed in baseline model due to linear preferences.
  - But if utility from monetary services is concave, can reduce the spread by having more money in the system.
- Greenwood-Hanson-Stein (2010): government can compress the spread by shifting issuance towards short-term T-bills.
  - Particularly helpful if cannot fully control privately-created money through direct regulation—say due to evasion of rules in shadow-banking sector.
  - Not a panacea since shorter government maturity has costs of its own (e.g. interferes with tax smoothing). But another potentially useful tool.

An Account of How Monetary Policy Works

- Positive-economics perspective: a model of bank lending channel of monetary policy. Three noteworthy features:
  - Prices are perfectly flexible.
  - Monetary policy influences bank lending and investment without moving open-market real rates by much.
    - Even if real rates on money and bonds are *fixed*, easing of MP lets banks finance more with cheap money—a pure quantity effect.
    - Central bank reserves as permits.
  - Central bank does not need to have monopoly control of household transactions media.
    - Can introduce, e.g., money market funds that hold T-bills and take deposits but aren't subject to reserve requirements—model works the same.
    - What matters is control of permits, not of all transactions-facilitating claims.

A Version with Imperfect Pledgeability

- In baseline model, there is no externality in low-M region.
- This changes if PIs can only capture a fraction $\varphi < 1$ of proceeds from investment.
- Now, fire sale discount is given by:

$$\frac{1}{k} = \varphi g'(W - M)$$

- Banks do not fully internalize consequences of fire sales for reduced output.
- So planner will always want to constrain money creation.

In Sum

- The fundamental financial-stability problem: banks like to issue short-term money-like claims because they are a cheap form of financing.
- This creates social value, but banks go too far: don't fully internalize fire-sale costs associated with short-term debt.
- How to address this problem?
  - In simple setting, monetary policy is a natural mechanism.
  - Along with deposit insurance and/or lender of last resort.
  - In more complex modern economies, need to also control money creation that happens in shadow banking sector.
  - All of these should be thought of as tools that central bank uses together to attack the one core problem.
  - Along with perhaps fiscal policy: government debt maturity.